IMPACT OF ANALOGY TEACHING FOR INNOVATION IN EVOLUTION CONCEPTS ON PRECONCEPTIONS AND PERFORMANCE AMONG NCE BIOLOGY STUDENTS IN NORTH CENTRAL, NIGERIA

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Abstract
This study investigated the impact of analogy teaching for innovation in evolution concepts on preconceptions and performance among Nigeria Certificate in Education Students in North Central Zone of Nigeria. The study adopted the pretest, posttest quasi-experimental control group design. Two groups were involved. The subjects of experimental group were taught evolution concepts using analogy teaching for innovation while the control group students were taught using lecture method. They were all taught for the period of six weeks. The population for the study was 1211 NCE III Biology students out of which a sample of 343 consisting of 203 males and 140 females were randomly selected after establishing their equivalence using pretest. The two instruments used were Unscientific Preconception Test on Evolution (UPTE) and Evolution Performance Test (EPT). These were adopted from biology textbook questions and past moderated NCE III examination questions. The questions were validated by experts in science education from ABU Zaria and with reliability coefficient of 0.69 for UPTE and 0.76 for EPT respectively. Two research questions were stated, and two null hypotheses were tested. The data collected were subjected to statistical analysis at p≤ 0.05 level of significance. Descriptive statistics was used to answer the research questions while t-test statistic was used to test the hypotheses on unscientific preconceptions and performance. The major finding from the study shows that there is significant difference in the unscientific preconceptions among NCE III biology students when taught using analogy teaching for innovation and lecture method in favour of analogy teaching for innovation. There is significant difference in performance in evolution concept taught using analogy teaching for innovation and lecture method in favour of analogy teaching for innovation. Based on the findings it was concluded that NCE III biology students learn evolution concepts better when taught using analogy teaching for innovation. It was therefore recommended that analogy teaching for innovation should be used by teachers of biology in teaching as it helps to shift unscientific preconceptions students' harbour, since this method creates a suitable foundation for subsequent meaningful learning. Students' performance was also enhanced in concept taught compared to using lecture method.

Introduction
Evolution concepts are aspect of biology curriculum, which students of Nigeria Certificate in Education (NCE) study at 300 level. However according to Kampourakis, K. (2014) evolution concepts are rather counter-intuitive ideas that generate unscientific preconceptions in students, make its theories difficult for them to understand, abstract in nature as well as having cultural and religious bias which has resulted in students performing poorly in evolution concepts at NCE level.

The theory of evolution unifies all biology concepts. This idea is well summarized in Dohzhansky's (1973) aptly titled paper; Nothing in Biology makes sense except in the Light of Evolution. Given the unifying and explanatory power of this theory, it would be reasonable to accept that its fundamental principles and concepts would be widely and

generally understood, especially by those studying the life sciences. However, as a large and continually growing body of research suggests, this is not the case (Nehm & Reilly 2007; Chinsamy & Plaganyi, 2008; Cunningham & Wescott, 2009; Pazz, Penteado & Kavalco, 2010). Even though biological evolution is the central organizing principle of modern biology, its theories are still unacceptable (NAS, 2008). Researchers like Alters and Nelson (2002), Hokayem and Boujaoude (2008) observed that it is widely known that large numbers of students in biology classes are woefully unprepared to undertake the study of evolution. However, according to Greg (2007) the teaching and learning of evolution has faced difficulties ranging from pedagogical obstacles to social controversy. These include two distinctive sets of problems: one arising from the fact that many evolutionary concepts may seem, at least initially, counterintuitive to students, and the other deriving from objections rooted in religion.

Bernardo and Clores (2007) reported that students' understanding of evolution theory especially origin of life varied due to the following reasons.

a. rejection of the theory due to challenges of religious beliefs;
b. remaining skeptical about the theory due to ambivalence that emanated from conflicting theological ideas and misconceptions held about human evolution.
c. Prior beliefs and concepts that were commensurate to the accepted scientific concepts and beliefs about evolution made learning of evolution complicated.

Cunningham and Wescott (2009) reported that students' understanding of evolution is limited even among those who accept the validity of evolutionary theory. They further explained that even acceptance of evolutionary theory does not imply understanding and that misconceptions must be identified if instructors are to assist students in undergoing conceptual change. Although many preconceptions are detrimental to learning, there may be other preconceptions that are largely in agreement with accepted physical theory. Therefore, preconceptions are the ideas that students have before coming into science class, these preconceived ideas may be right in line with scientific views as such will serve as the bases for new knowledge or experiences that can be built upon. Read (2004), Clement, Brown, Zietsman, (1989) added that if students' preconceived idea is wrong that is, unscientific and not in line with scientific views, the preconceived idea needs to be corrected first before new knowledge can be learnt. This is in line with Hodge (1993) reported that preconceived ideas are not scientific ideas or theory are referred to as misconceptions and must be corrected before new knowledge is learnt. Misconceptions are experiences encountered in daily life, traditional instructional language, teachers, misunderstandings of theory, mismatches between teachers and students' knowledge of science.

Okebukola (2002) confirms that the existence of unscientific preconception in the learner is clear evidence that new concepts cannot be learned as an alternative model that explains a phenomenon already existing in the mind. Okebukola (2002) stresses further that these unscientific preconceptions needed extra efforts on the part of the teacher to affect any correction in the learner. This is due to the wrong preconception (unscientific) has on the learning of science. Wasagu (1999) observed that for several years now, scientific knowledge has not been an integral part of African social life because the minds of many Africans are loaded with power of witchcraft and superstitious beliefs in providing explanations to natural phenomena. An example is the replacement of indigenous reasons for recurrent infant mortality in a home by a scientific reason such as sickle cell. If a student who holds the "*Abiku*" or "*Ogbanje*" conception comes in contact with the sickle cell phenomenon in a biology class, the sickle cell idea is very likely to challenge the "Ogbanje" and "Abiku" unscientific preconception.

Studies by Demircioglu, Ayas and Demircioglu (2005) Cunning and Wescott (2009) suggest that most presently used traditional methods of teaching evolution are relatively ineffective at dispelling unscientific preconceptions and increasing acceptance of evolution. Okoroka, (2004) suggest activity-oriented strategies such as analogy teaching for innovation, cooperative learning, think and do, collateral learning, among others. Analogy is a process of identifying similarities between two concepts, the familiar concept is called the analogy and the unfamiliar science concept is called the target. According to Treagust (1993), the goal of Analogy is to transfer ideas from a familiar concept (the analogy) to an unfamiliar one (the target). If both the analogy and the target share some similar features, an analogy can be drawn between them. Ruhl (2003) also stated that analogy is a comparison of something unfamiliar with something familiar to explain a shared principle. Ruhl (2003) describes analogy teaching for innovation like a bridge that spans the gap between what a teacher wants students to learn and what the students already know. An analogy teaching for innovation builds on the framework of the learners existing knowledge so they are not starting from scratch. Lagoke (2000) and Jiya (2011) revealed that a growing amount of research has shown that the use of analogy teaching for innovation in sciences promotes meaningful understanding of complex scientific concepts and helps students to overcome preconception science concepts that they may harbor. Sani (2006), James and Schamann (2007), Diber and Duzgun (2008) reported three benefits of using analogy as a teaching innovation for abstract concepts. These include providing visualization of abstract concepts, helping to compare similarities of the students' real world with the new concept and having a motivating function.

In this study, Analogy Model of Glynn (2007) teaching for innovation adopted emerged as the best suited for use in colleges of education biology classrooms, because it focuses on the learner in class presentation of the analogy teaching for innovation and can be easily implemented and evaluated. Above all, it puts into consideration the prior knowledge of the learner, which constructivist like Miller (1989) believed that for meaningful learning to take place, students' involvement in integrating new information or knowledge with pre-existing is necessary. Therefore, analogy teaching for innovation was used to teach NCE III biology students.

Objectives of the Study

The main objectives of this study are to examine the impact of analogy teaching for innovation in evolution concepts on unscientific preconceptions and academic performance among NCE III biology students. The study has the following specific objectives to determine:

(i) the impact of analogy teaching for innovation and lecture method on unscientific preconceptions in evolution concepts among NCE III Biology students;
(ii) the impact of analogy teaching for innovation and lecture method on academic performance in evolution concepts among NCE III biology students;

Research Questions

The study sought to answer the following research questions:

(i) What is the difference in the unscientific preconceptions mean scores in evolution concepts among NCE III biology students taught using analogy teaching for innovation and those taught using lecture method?
(ii) What is the difference in academic performance mean scores in evolution concepts among NCE III biology students taught using analogy teaching for innovation and those taught using lecture method.

Null Hypotheses

The following null hypotheses were tested in the course of this study at $p \leq 0.05$ levels of significance:

Ho_1: There is no significant difference in the unscientific preconceptions mean scores in evolution concepts among NCE III biology students taught using analogy teaching for innovation and lecture Method.

Ho_2: There is no significant difference in academic performance mean scores in evolution concepts among NCE III students taught using analogy teaching for innovation and those taught using lecture method.

Methodology

The study adopted pretest, posttest quasi experimental control groups design as recommended by Kerlinger (1973). Two groups were involved, the experimental group and the control group. The two groups were pretested using Evolution Performance Test (EPT) before the commencement of the treatments in order to determine the equivalence of the two groups in their ability level. The experiment group was taught evolution concepts using Analogy teaching for innovation, while the control group was taught evolution concepts using lecture method. The population of this study comprised all the NCE III Students of the Department of Biology in Colleges of Education in North Central Zone, Nigeria. There were 12 colleges of education in the zone. The target population was 1211 comprising 683 males and 528 females. The colleges of education used as sample for the studies are intact classes. A sample of 343 students made up 203 male and 140 females were randomly selected after establishing their equivalence using pretest scores. Their age range was between 18 and 22 years.

The instruments used for data collection were Unscientific Preconception Test on Evolution (UPTE) was made up of 15 short structure questions and Evolution Performance Test (EPT) made up of 50 multiple choice questions. The UPTE and EPT were validated by two chief lecturers from college of education and two senior lecturers from Science Education Department ABU Zaria. The reliability coefficient of 0.69 and 0.76 was calculated for the two instruments using re-test method (Tuckman, 1975 & Sambo, 2005).

The experimental group was taught evolution concepts using analogy teaching for innovation, while the control group was taught evolution concepts using lecture method. Both the experimental and control groups were taught for a period of six weeks. After treatment EPT and UPTE were administered to the subjects of the two groups as posttest to determine the effectiveness or otherwise of the two strategies employed in the teaching of the concepts. Two research questions and two hypotheses were tested; descriptive statistics was used to answer the research questions and t-test was used to test stated hypotheses at $p \leq 0.05$ level of significance.

Results

Research Question One: What is the difference in the unscientific preconceptions mean scores in evolution concepts among NCE III biology students taught using analogy teaching for innovation and lecture method?

To answer research question one the scores collected were analyzed using descriptive statistics in form of mean scores as shown in Table 1.

Table1: Mean and Standard Deviation Results from Unscientific Preconceptions Test on Evolution for Experimental and Control Groups

Strategies	N	Pre-test	Posttest	SD	mean gain
Analogy teaching innovation	216	8.13	23.84	7.96	15.71
Lecture method	127	6.92	7.61	3.88	0.69

Result on Table 1 showed that there was difference in the pretest and posttest mean score unscientific preconception of subjects. After treatment the subjects mean scores increased showing that the treatment had positive impact on their unscientific preconceptions. Experimental group had mean gain of 15.71 while the control group gained only 0.69. From the mean scores, the experimental group outperformed the control group on evolution concepts by overcoming their unscientific preconceptions at NCE level. The mean scores for unscientific preconceptions in evolution were 23.85 and 7.61with mean difference of 16.23 when taught using analogy teaching for innovation and lecture method respectively. The mean score for analogy teaching for innovation was higher than that of lecture method. Therefore, difference existed in the unscientific preconceptions scores in evolution concepts for experimental group taught using analogy teaching for innovation and the control group taught using lecture method.

Null Hypothesis

$H0_1$: There is no significant difference between the unscientific preconceptions mean scores in evolution concepts among NCE III Biology Students taught using analogy teaching for innovation and those taught using lecture method.

Table 2: Results of Unscientific Preconception Mean Scores in Evolution Concepts among NCE III Biology Students taught using Lecture Method and Analogy Teaching for Innovation

	N	Mean	Std. Dev.	df	t_{cal}	p-value	Remark
Lecture Method	127	7.61	3.88				
				341	21.55	.000	S
Analogy Teaching Innovation	216	23.86	7.96				

Significant at P ≤ .05

Table 2 revealed that the p-value (0.000) is less than the .05 level of confidence. Therefore, hypothesis is rejected. This implies that a significant difference exists between the two teaching strategies. But p-value of 0.001 was observed between analogy teaching for innovation and lecture method which was lower than the 0.05 significant level. This indicates that students taught using analogy teaching for innovation performed significantly higher than those taught using lecture method. This implies that analogy teaching for innovation had the potentials of helping students overcome their unscientific preconceptions in evolution better than lecture method.

Research Question Two: What is the difference in academic performance mean scores in evolution concepts among NCE III biology students taught using analogy teaching for innovation and lecture method.

To test the hypothesis t-test was adopted to analyse the data as shown in Table 3

Table 3: Mean and Standard Deviation Results of Evolution Performance Test for Experimental and Control Groups

Group	N	Pretest	Mean	Std. Dev.	Mean Diff
Analogy Teaching for Innovation	216	8.13	24.75	4.60	16.65
Lecture Method	127	6.92	9.13	3.02	2.21

Result on Table 3 showed that the pretest and posttest mean scores of evolution performance test for experimental and control groups. From the table performance means scores in evolution concepts by students taught using analogy teaching for innovation and lecture methods were 24.78 and 9.12 respectively; with analogy teaching for innovation scoring the highest and lecture method scored the lowest. The mean difference in analogy teaching for innovation and lecture was 16.23, respectively.

$H0_2$: There is no significant difference between academic performances mean scores in evolution concepts among NCE III Biology Students taught using Lecture method and analogy teaching for innovation.

Table 4: Result of NCE III Biology Students taught Evolution Concept using Lecture Method and Analogy Teaching for Innovation

	N	Mean	Std. Dev.	df	t_{cal}	p-value	Remark
Lecture Method	127	9.13	3.02				
				341	34.21	.000	S
Analogy Teaching for Innovation	216	24.75	4.60				

Significant at $P \leq .05$

Table 4 revealed that the p-value (0.000) is less than the .05 level of confidence. Therefore, hypothesis two is rejected. This implies that there is a significant difference in the academic performance of NCE III Biology students taught using analogy teaching for innovation and lecture method, in favour of students taught using analogy teaching for innovation.

Discussion of the Results

The finding reveals that students taught the concepts of evolution using analogy teaching for innovation performed better than those taught with lecture method. The findings agrees with that of Jiya (2011) who reported positive effect of analogy teaching for innovation on academic performance and retention when students prior knowledge was put into consideration by the introduction of something familiar. Similarly, it agrees with that of Orgill and Bodner (2004) who clearly stated that analogy innovation can play a very vital role in promoting conceptual change by helping students overcome existing unscientific preconceptions because something familiar was used to explained unfamiliar difficult science concept. They also agreed that analogy teaching for innovation can help students recognize errors in their conceptions they currently hold, reject those conceptions, and adopt new conceptions that are in line with those accepted by the scientific community.

Table 2 The study also revealed that students taught using analogy teaching for innovation performed better than those taught using lecture method. The findings agree with the findings of Sani (2006) who independently reported that students taught using analogy teaching for innovation performed significantly better than those taught using lecture method this is because the students' concept of learning was enhanced by the spontaneous introduction of familiar experiences. Similarly,Thiele and Treagust (1994) agreed that analogy innovation can make new material interesting to students, particularly when the analogy innovation relates new information to the students' real world experiences. Studies

conducted by Aubusson, Treagust and Harrison (2009) Ayanda, Abimbola and Ahmed (2012) highlighted that analogy teaching for innovation provides visualization of the abstract ideas by pointing to similarities in the real world, facilitates understanding of abstract concepts, arouse students' interest that may have motivation function, they are valuable tools in conceptual change learning.

Conclusion

Students held unscientific preconceptions about evolution concepts in biology at NCE level, and these unscientific preconceptions were shifted when taught evolution concepts using analogy teaching for innovation as revealed in this study. The analogy teaching for innovation has the potentials of enhancing NCE III students' performance when taught evolution concepts in biology than lecture method. This is because prior knowledge was used to link what the teacher wanted the students to learn and what the students already knew to explained difficult concepts among others.

Recommendations

Based on the findings from this study the following recommendations are made:

(i) The management of Colleges of Education in Nigeria, NCCE and Universities should encourage the teachers of biology to use Analogy teaching for innovation in teaching as it helps to shift unscientific preconceptions students' harbor, since it creates a suitable foundation for subsequent meaningful learning. Academic performance is also enhanced in students in concept taught compared to using lecture method.

(ii) College managements, Science teachers' association of Nigeria, Mathematical association of Nigeria should organize seminars, workshops and conferences for training and re-training of biology teachers on the use of analogy teaching for innovation.

(iii) Book writers, publishers should give examples of how to use analogy teaching for innovation in simplifying some difficult biology concept in biology textbooks in order to enhance better understanding and easier access.

(iv) Professional bodies should encourage science teachers to identify students' preconceptions (unscientific) and use analogy teaching for innovation to correct it since students' performance was enhanced in concept taught compared to using lecture method.

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